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Effects of Arousal on Memory and Judgment

by

Judy A. Lau

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A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE

OF Master of Arts

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled EFFECTS OF AROUSAL ON MEMORY AND JUDGMENT submitted by Judy Lau in partial fulfilment of the requirements for the degree of Master of Arts.

Brendan Park Rule
Supervisor

R B Westbury

Allan R Wells

Date: August 5, 1986 1986

Dedication

This thesis is dedicated to

my Father in heaven, the most gracious One

Abstract

In two experiments, we tested whether arousal may act as a retrieval cue and prime arousal-related material in memory in University students. Subjects learned and recalled one list of words in a high-aroused state and one list in a neutral-aroused state. Then they recalled both lists in either state. Contrary to predictions that arousal may act as a retrieval cue and prime arousal-related materials in memory, recall in congruent arousal states did not differ from recall in non-congruent arousal states. Furthermore, high arousal items were not better recalled in the high arousal recall state. The results were explained from a theoretical as well as a methodological point of view. It was concluded that arousal may not be an important component in inducing mood state dependent retention and mood retreival effects.

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I. INTRODUCTION

At one time or another, we probably have told others that we are in a good or a bad mood and therefore may act differently from what we otherwise would do. More often, when we behave unseemingly or do not behave as well as we should, we excuse ourselves by saying that we are in a bad mood. We may also explain our hyperactive behavior as owing to our existing good mood. Similarly, we may treat people quite differently if we feel that they are in a good or bad mood. When we notice that a person is in a bad mood, we may withhold information until he or she returns to a normal mood, or we may postpone a request until that person is in the right mood to grant our request. When we notice that a person is in a good mood, we grasp the opportunity to ask for a favour without any delay.

Research also shows that moods affect memory, judgment, decision making, as well as social behavior. Materials learned and recalled under similar moods were better recalled than materials learned and recalled under different moods (Bower, Monteiro, & Gilligan, 1978; Leight & Ellis, 1981; Macht, Spear, & Levis, 1977; Weingartner, Miller, & Murphy, 1977). This effect, commonly known as mood-state dependant retention, was observed in multi-list learning circumstances where learning mood provided a helpful retreival cue and differentiating context (Bower et al, 1978). Students hypnotized to feel sad and then happy recalled a higher percentage of abstract words from the list learned in a congruent mood when they recalled both lists in either mood. The same restriction of multi-list learning circumstances was suggested to be crucial in producing mood-state dependent retention by Leight & Ellis (1981). Macht et al (1977) showed mood-state dependent retention in only one of their 3 studies. In that particular study more nouns were recalled when subjects received shock in both the learning and recall phases, as opposed to when subjects received shock in only one phase. Thus, a mood manipulation (shock) seemed to have the potential of producing state dependent retention (SDR). However, they were unable to replicate the results in subsequent studies when they used galvanic skin response to measure the subjects' anxiety level. Macht et al (1977) concluded that a mood manipulation had the potential to produce SDR, but they were unable to specify

which variables were important in producing it.

Another type of mood effect is the mood congruent effect in which the encoding mood is important. In the SDR model, all materials are presumably better recalled when they are learned and recalled in a congruent mood, whereas according to the mood congruent model, only material congruent with the valence of the encoding mood will be subsequently better recalled in a neutral mood. Indeed, happy and angry mood facilitated encoding of positive and negative adjectives respectively in children who were made to feel either happy or angry by imagining a relevant personal experience (Nasby & Yando, 1982). A sad encoding mood, however, did not facilitate recall of negative materials in a neutral mood (Nasby & Yando, 1982). On the other hand, college students hypnotized to feel either happy or sad recalled more happy or sad incidents from prose passages depending on their mood at learning (Bower et al, 1981). Because mood congruent effects have not been widely researched, few conclusions can be drawn.

On the contrary, mood retreival effects have been extensively studied. Such effects differ from the mood congruent effects in that the recall mood, instead of the encoding mood, is important. The retrieval effect occurs when the encoding mood is neutral, and materials with the valence similar to the valence of the recall mood are better recalled than materials that have an opposite valence (e.g. Laird, Wagner, Hagal, & Szeda, 1982; Natale & Hantas, 1982). Such effects have been shown in episodic as well as semantics materials in memory. Hypnotic-induced depression caused a decrease in recall of positive life experiences, weaker memory for positive information about oneself, and a bias to recall false negative descriptions. Induced elation decreased recall of negative events and increased recall of positive events (Natale & Hantas, 1982). Similar results were obtained using extremely happy and unhappy life experiences as the recall materials (Teasdale, Taylor, & Fogarty, 1980). Anger provoking editorials were also better recalled when participants were in a frowning state, while a Woody Allen comedy was better recalled when participants were in a smiling recall state (Laird et al, 1982). Using words as recall material, more positive words were recalled in an elated mood than

in a depressed mood, while more negative words were recalled in the depressed mood (Teasdale & Russell, 1983).

Thus, recall mood affect both the type of material to be recalled and the time to retrieve or remove such material. Time to retreive pleasant life experiences, relative to time to retrieve unpleasant life experiences, was longer when subjects were depressed than when they were happy (Teasdale & Fogarty, 1979). In another study (Sutherland, Newman, & Rachman, 1982), depressed individuals took longer to remove unwanted negative thoughts than to remove neutral thoughts from their mind.

In summary, both positive and negative mood at recall affect the type of material recalled and the time to retrieve or remove certain types of thoughts from the mind. Positive recall mood increases recall of pleasant materials and decreases time of retrieval of pleasant thoughts while negative mood increases recall of unpleasant materials, and increases time of removal of unpleasant thoughts from the mind. One major criticism of the studies in this area concerns the selective sampling of the populations studied. Because most studies (Natale & Hantas, 1982; Sutherland et al, 1982; Teasdale & Fogarty, 1979; Teasdale & Russell, 1983; Teasdale, Taylor, & Fogarty, 1980) used either hypnosis or the Velton Mood Induction Procedure to induce mood, only highly suggestible subjects were chosen. These people are also those who are more susceptible to demand characteristics. Another problem is that some studies failed to find mood retrieval effects in negative moods (e.g. Nasby & Yando, 1982; Teasdale & Fogarty, 1979). Selective retrieval of positive adjectives occured in happy moods but selective retrieval was not evident in sad moods (Nasby & Yando, 1982). Retrieval latency of pleasant experiences was significantly faster in happy moods than in depressed moods while retrieval latency for unpleasant experiences did not differ in happy and depressed moods (Teasdale & Fogarty, 1979).

A similar asymmetrical effect of mood was evident in studies concerning judgments made in different kinds of mood. That positive affect biases judgment in the direction of more positive evaluation has been demonstrated repeatedly (Isen, Shalker,Clark, & Karp, 1978;

Clark, Milberg, & Erber, 1984; Isen & Shalker, 1982; Schwartz & Clore, 1983). People in a pleasant mood evaluated slides as more pleasant (Isen & Shalker, 1982), performance and service records of products as more positive (Isen et al, 1978) and life as having more happiness and satisfaction (Schwatz & Clore, 1983). Relatively few studies have demonstrated biased judgment in negative moods except in a study by Schiffeubaun (1974) in which subjects in a disgusted mood gave more disgust labels after viewing slides of different facial expressions. The above effect of mood led Isen et al (1978) to suggest that the effects of positive and negative moods may be asymmetrical. This speculation, however, did not take into consideration the existing literature that reported symmetrical effects. It does not, moreover, consider the fact that most studies on negative moods have exclusively used a sad mood or depression. Unless more negative results are obtained using different kinds of negative moods, the conclusion that positive and negative moods produce asymmetrical effects may be too hasty.

The theory proposed by Bower (1981) to explain mood effects necessitates symmetrical effects of positive and negative moods. Bower (1981) explained mood congruent and SDR results in terms of an associative network theory of memory and emotion. In the semantic network theory of memory and emotion, it is proposed that each emotion has a specific node in memory connected to events that arouse that emotion. Activation of an emotion node will spread activation to connected nodes, creating subthreshold excitation at these event nodes. If excitation from an emotion node raises the activation of a relevant memory above a threshold, that information becomes more accessible. In SDR, materials learned in a particular emotional state (emotion 1) became associated to the unit describing that emotion (emotion 1). Later, when asked to recall the materials learned in a similar state of emotion, the activation from emotion 1 state will spread along its associative links to the target items, causing these items to be more accessible. When materials learned are to be recalled in a different state, emotion 1 will not be activated to spread its activation to the target items. In mood congruity or mood retrieval states, descriptions of emotional events feed excitation into similarly toned emotional

nodes. Thus, in a happy encoding or recall state, a happy event will feed excitation into the happiness node which, in turn feeds activation back to the happy event, strengthening the association between the happiness node and the happy event. In contrast, when a happy subject reads about a sad event, activation from the sad event will spread activation to the sadness emotion node. This in turn dampens or inhibits the prevailing happy mood. Consequently, links to mood-congruous events are stronger than links to incongruous events, causing mood-congruous events to be more accessible.

Isen et al (1978) and Clark & Isen (1982) also used "spreading activation" theory to explain increased accessibility of similarly toned material in mood retrieval and mood judgment studies. Clark & Isen (1982) suggested the possibility that feelings are linked to nodes representing individual behaviors or circumstances. It is also possible that experiences are linked in memory according to how they make the person feel. In both cases, the feeling state becomes an informational node as well. Mood may activate nodes representing moods in memory and activation may spread to materials linked to these nodes, causing these mood-related materials come to mind more readily.

Teasdale & Russell (1983) expressed a similar explanation in another way. They regarded mood as the relevant context that enhances the accessibility of trait words originally encoded in such a mood context. That context was regarded by Weingartner et al (1977) as a brain state present at the time an event is processed and stored in memory. In fact, Weingartner et al (1977) suggested that certain discrete pharmacological manipulations of brain state directly altered the encoding events.

Clark, Milberg, & Ross (1983) also used "spreading activation" theory to explain mood-congruent effects. However, they thought that the "spreading activation" theory still leaves unanswered the question of how moods are represented in memory. They proposed and presented a case to show that autonomic arousal that accompanies mood may be part of how mood is stored in memory, i.e. arousal is one element linking mood and similarly toned material. It is important to note that Clark et al (1983) did not mean that arousal

accompanying different emotional states is undifferentiated, rather, the information stored in memory about the arousal states that accompany different emotions might be quite similar.

There are definite advantages of Clark et al (1983)'s proposal over Bower (1981)'s theory. First, the former is a more specific version of the "spreading activation" theory. While in Bower (1981)'s theory, mood is assumed to be an information node connected to similarly toned material, in Clark et al (1983)'s proposal, mood is assumed to be represented in part in memory by an arousal information node connected to similarly toned material. Second, Clark et al's proposal explained why some studies have negative mood effects while others did not have such effects. If arousal is an element linking mood and similarly toned material, we will not expect a sad mood to prime negative materials because a sad mood is usually accompanied by a low level of arousal. Because most studies not reporting negative mood effects (Bower et al, 1978; Isen et al, 1978; Isen & Shalker, 1982; Teasdale & Fogarty, 1979) have exclusively used sad mood and depression as their negative mood, their lack of results is not surprising. On the other hand, studies that reported effects of negative mood have either used angry moods (Laird, Wagener, Hagal, & Szeda, 1982; Nasby & Yando, 1982) or subjective life experiences as recall material (Natale & Hantas, 1982; Teasdale & Fogarty, 1979; Teasdale et al, 1980). Angry moods and life experiences are obviously more arousing than are sad mood and negative words.

To make a case that arousal is one element linking present moods to affectively toned material, Clark et al (1983) suggested that a three-part presentation was needed:

> "(i) evidence that positive moods are accompanied by changes in arousal, (ii) change in arousal can be stored in memory and can serve as a retrieval cue, (iii) arousal may contribute to the priming of emotional materials in memory."

Evidence that positive moods raised level of arousal were presented. Change in arousal was then demonstrated to be a retrieval cue in two studies. In both studies, subjects learned a list of phrases while experiencing enhanced arousal and a second list while experiencing normal arousal. Later, they were given an incidental recall test for phrases learned on both lists when they were either experiencing enhanced arousal or normal arousal. Results showed that material

learned is subsequently best recalled when the recall arousal state was similar to the learning arousal state. A third study showed that elevated arousal in conjunction with a positive mood enhanced judgment in the positive direction, whereas arousal itself had no impact on judgment.

The case reported by Clark et al (1983) to support their proposal has one shortcoming, in that only one level of arousal was manipulated by mild exercise in the first study and by watching a sexually explicit film in the second study. The use of mild exercise or an erotic film may produce positive mood in addition to arousal. The arousal manipulation might be confounded in this sense. Thus, the first part of the present study sought to establish results that support the second part of Clark et al's idea using a higher level of arousal. This allowed us to see if a different level of arousal would serve as a retrieval cue. Strenuous exercise was used to induce the required level of arousal. Strenuous exercise, in contrast to mild exercise or an erotic film, was expected to produce arousal without either positive or negative mood in addition to arousal, thus rendering the arousal manipulation clear of any confound. The next deviation from Clark et al's study lay in the material used for learning and recall. In Clark et al's study, phrases presumed to be high or low in arousal were used but the high arousal items were not better recalled in the high arousal recall state. The authors explained the results as a lack of validity in items. They argued that what their judges prerated as more emotional than other terms (e.g. "failed exam" was rated as more emotional than "wide road") did not mean those phrases were actually stored with enhanced arousal in their subjects' memories. Many students do not fail exams and therefore do not find the phrase "fail exam" arousing.

In our study, we used words that have established emotionality from word norms. Because multi-list learning was suggested to be important to produce SDR (Bower et al, 1978; Leight & Ellis, 1981), and was also used in Clark et al's study, two lists of items were used. In our study, each subject learned one list in an aroused state, one list in a relaxed state, and were required to recall both lists under either state. It was expected that the list learned and recalled under similar arousal states would be better recalled than the list learned and recalled under different arousal states. Futhermore, with arousal present at recall, materials with high

emotionality, both positive and negative, were expected to be more accessible. These findings would support the notion that change in arousal level can be stored in memory and can serve as a retrieval cue.

The second part of the study investigated the effects of high arousal on judgment of others' emotion. If arousal is one element linking mood and similarly toned material from memory, high arousal level at recall should increase accessibility of arousal-related information. As more arousal-related material comes to mind, this type of information is likely to bias subsequent judgments. Thus, people in a state of high arousal are likely to bias their judgment of others' emotions in the direction of higher arousal level. This argument led Clark et al (1984) to test the following hypothesis:

> "(a) increases in arousal would increase the likelihood that subjects would intepret positive statements and positive emotion facial expressions as indicating a positive emotion associated with high arousal (joy) rather than a positive emotion associated with low arousal (serenity), and (b) increase in arousal would increase the likelihood that subjects would intepret negative statements and negative expressions as indicating a negative emotion associated with high arousal (anger) rather than a negative emotion associated with low arousal (sadness or depression)."(p.)

Although the first hypothesis was confirmed in their study, the second was not. Several explanations were offered. Based on the findings that subjects who imagine anger experienced greater increase in blood pressure and heart rate than did subjects who imagined happiness (Weinberger & Singer, 1981), Clark et al (1984) suggested that moderate levels of arousal may be associated with joyful thoughts while high levels of arousal may be associated with angry thoughts. Another explanation was that moderate exercise might be more likely to prime joy than anger. A final explanation assumed that joy and serenity differed only in the dimension of arousal whereas sadness and anger differed in a more complex way.

In order to examine the effects of arousal on negative stimuli, changes and additions to Clark et al's study (1984) were introduced in the present study. To increase the level of arousal in favour of showing biased judgment of negative stimuli, more strenuous exercise was used. Second, using two states qualitatively similar in all aspects except the degree of arousal (e.g. anger and rage) might reflect the expected bias in negative stimuli.

II. METHOD

A. Subject

The subjects were 48 Introductory Psychology students at the University of Alberta. The students participated as an option for fulfilling their course requirement. Only males were used because they have been shown to be less variable in similar experimental situations (e.g. Bower et al, 1978; Macht et al, 1977). In addition because only a female experimenter was used, we wished to avoid a possible interaction between the subjects' sex and the experimenter's sex. Such an interaction may affect the emotional state of subjects and obscure the effect of exercise on them.

B. Materials

Two lists of words were prepared for the first part of the study. The words were selected from "the ratings of 650 words" reported in Ure & Brown (1969). Each list consisted of four high emotional pleasant words, four high emotional unpleasant words, four neutral emotional pleasant words, four neutral emotional unpleasant words, and four neutral emotional neutral pleasantness words. These five types of words were matched on concretness, emotionality, and pleasantness according to ratings reported in Anderson (1965) and Ure & Brown (1969). Thus, the two lists, hereafter referred to as list A and list B did not differ in their average concretness, emotionality and pleasantness ratings (See Appendix 1 for list A and list B).

For the second part of the study, phrases which express either a feeling of sadness or distress were written. Five phrases were selected on the basis of their face validity and variability in content (list C). Similarly, phrases that express either "annoyed" or "rage" were written and five phrases were selected to make up list D. Phrases selected on the "apprehensive or terrified" and "glad or ecstatic" dimensions made up list E and list F, respectively (See Appendix 2 for list C to list F). The actual layout of list C to list F is provided in Appendix 3.

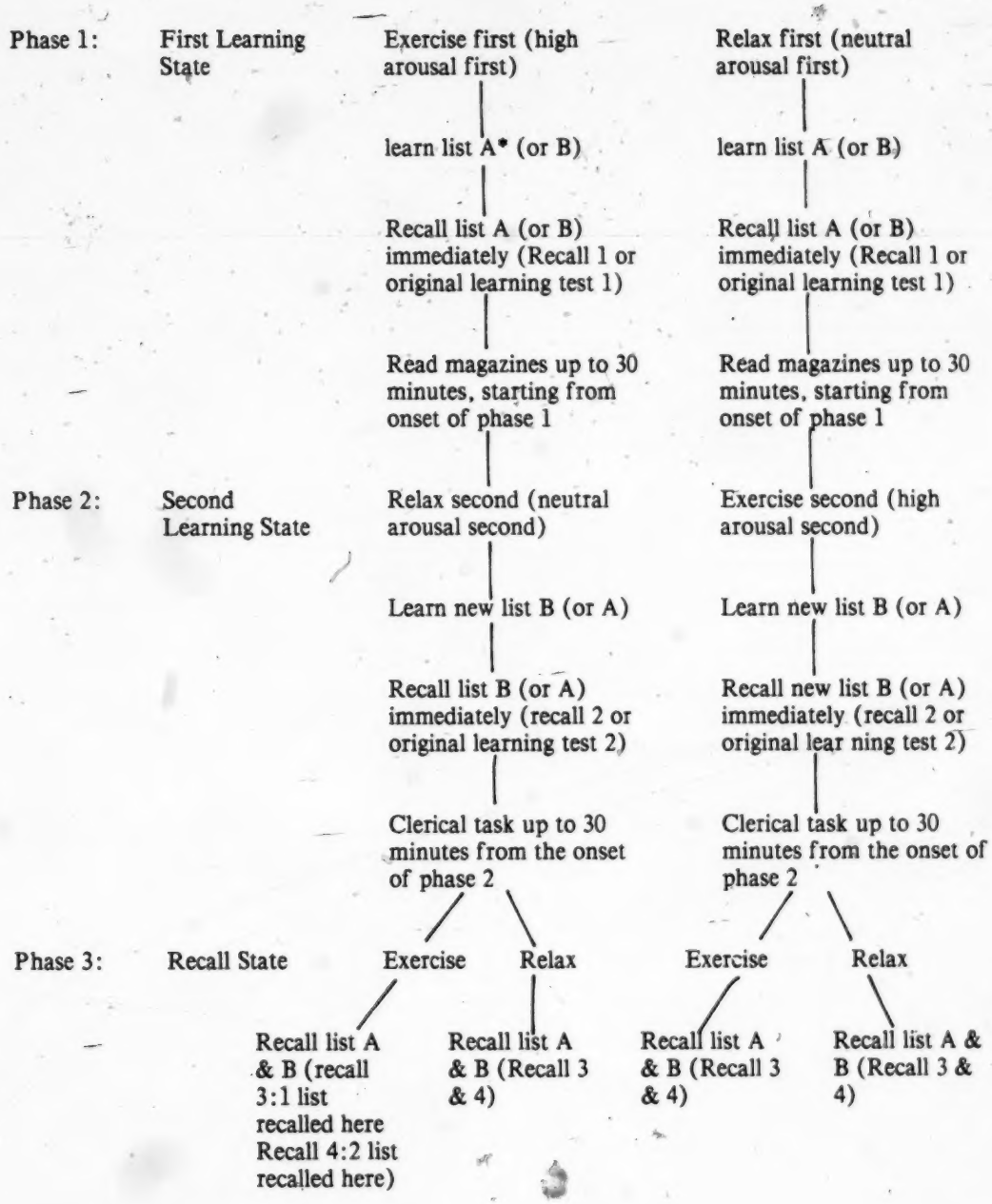
Seven-point scales were provided for subjects to rate their subjective state of physiological arousal under exercise and under relaxation. Two other 7-point scales were used for tapping subjects' subjective feeling of pleasantness and emotionality immediately after exercise (See Appendix 4 for the questionnaire. Scores ranged from 1 (low) to 7 (high).

C. Procedure

Upon arrival, subjects were told that the purpose of the experiment was to investigate the effects of various types of distraction on learning. They were told that they had to learn and recall a list of words after exercise, relaxation, visual distraction, and noise distraction. The whole study, it was explained, would be run in two sessions: the first session consisted of exercise and relaxation, while the second consisted of visual and noise distraction. Between the two sessions, there would be a break during which subjects would perform some clerical tasks.

After subjects were told the purpose and procedure of the experiment, they were asked to fill out a questionnaire to see if they were fit for exercise. The questionnaire was adapted from one suggested in Morse (1972) to screen for any signs of cardiovascular disease. Questions as to whether subjects have any kind of heart disease and whether they have any problems after exercise were asked (See Appendix 5 for the full questionnaire). Three subjects did not meet these criteria. One subject indicated that he suffered from shortness of breath after minor exercise. Another two reported the presence of asthma. Finally, one had a broken leg that prevented him from pedalling on the bike. Those subjects that answered "no" on all questions were randomly assigned to either "exercise first" or "relax first" condition. Half of the subjects started the study with the exercise task (high arousal), and half with the relaxation task (normal arousal). Regardless of whether they "exercise first" or "relax first", each subject went through all the three phases of the experiment (See Figure 1).

Chart of Condition Order


Phase 1:
First Learning State
Exercise first (high arousal first)
Relax first (neutral arousal first)
learn list A* (or B)
learn list A (or B)
Recall list A (or B) immediately (Recall 1 or original learning test 1)
Recall list A (or B) immediately (Recall 1 or original learning test 1)
Read magazines up to 30 minutes, starting from onset of phase 1
Read magazines up to 30 minutes, starting from onset of phase 1
Phase 2:
Second Learning State
Relax second (neutral arousal second)
Exercise second (high arousal second)
Learn new list B (or A)
Learn new list B (or A)
Recall list B (or A) immediately (recall 2 or original learning test 2)
Recall new list B (or A) immediately (recall 2 or original lear ning test 2)
Clerical task up to 30 minutes from the onset of phase 2
Clerical task up to 30 minutes from the onset of phase 2
Phase 3:
Recall State
Exercise
Relax
Exercise
Relax
Recall list A & B (recall 3:1 list recalled here Recall 4:2 list recalled here)
Recall list A & B (Recall 3 & 4)
Recall list A & B (Recall 3 & 4)
Recall list A & B (Recall 3 & 4)

* See Appendix 7 for list order and counterbalancing.

Fig.1 Chart of Condition Order

Phase 1. Those assigned to the "exercise first" condition pedalled on a stationary bike for 2.5 minutes. They were told to make 9 revolutions every 10 seconds to give an energy output of approximately 140 Watts. This duration and energy expenditure of pedalling on a bike were shown to be an effective manipulation of physiological arousal. Zillmann, Katcher, & Milarsky (1972) reported an increase of 53.5 beats per minute in heart-rate changes before and after cycling. Those assigned to the relaxation task simply sat on a chair in a quite room for 2.5 minutes.

Immediately after this experience (high or normal arousal), all subjects were required to learn and recall a list of 20 words (either list A or list B). The list was read aloud by the Experimenter at the speed of 1 word every 2 seconds. The list was repeated at the same speed for a second time. Subjects were then given 3 minutes to recall as many words as possible on a piece of paper. This recall is referred to as the original learning test 1 (or recall 1) in the subsequent sections of the thesis.

At this point, subjects rested until 30 minutes had elapsed since the subject had originally exercised or relaxed. This time period was established to be sufficient for the exercise subjects to return to a normal arousal state in the pilot study. During this period, two Popular Science magazines and a motor vehicle magazine were provided for the subjects to read to reduce boredom.

Phase 2. After this resting period, subjects who exercised first relaxed for 2.5 minutes and subjects who relaxed first exercised for 2.5 minutes. They then learned and recalled another list of 20 words. This recall is subsequently referred to as the original learning test 2 (or recall 2).

After this second learning session, all subjects worked on some clerical tasks timed for 30 minutes from the onset of Phase 2. This was done to ensure that the "exercise" subjects returned to their normal state of arousal and to minimize boredom.

Phase 3. At the end of the clerical task, they were told that an error had been made in one of the previous phases and therefore it was necessary for them to go through that phase

again. Half of the subjects who had exercised first and then relaxed were assigned either to an exercise or relaxation condition and half of those who had relaxed first and then exercised were then assigned to either exercise or relaxation condition. After 2.5 minutes of either exercise or relaxation, the Experimenter unexpectedly asked them to recall as many words as possible from each of the two lists of words learned earlier. The first list recalled is later referred to as the first recall in the recall state (or Recall 3). The second list recalled is referred to as the second recall in the recall state (or Recall 4).

Immediately after this recall, subjects were given 4 lists of phrases to judge the emotion of the people who said those phrases. Each subject rated each phrase on a 7-point scale ranging from "sad (1) to distress (7)", "annoy (1) to angry (7)", "apprehensive (1) to fear (7)", or "glad (1) to ecstatic (7)".

Pulse rates of subjects were taken immediately before any experimental manipulation, after exercising, and after relaxing. Pulse rates at the recall state were also taken immediately after exercise or relaxation. For the first 23 subjects, their pulse rates were taken by an optical plethysmograph attached to the subject's finger and were monitored via an Aim 65 microcomputer (Rockwell International) for 2.5 minutes. For the rest of the subjects, pulse rates were taken by hand for one minute due to the breakdown of the equipment.

Finally, subjects completed 7-point scales on their subjective state of physiological arousal after exercise, after relaxation, and their subjective feeling of pleasure and emotionality after pedaling on the bike. After they had finished, they brought the questionnaire back to the experimenter, were debriefed and thanked for their participation. The debriefing script is presented in Appendix 6.

D. Design

The design was a mixed design with arousal level at learning as the within-subject variable and the arousal level at recall as the between-subject variable. This resulted in each

subject's experiencing 2 levels of arousal at learning and only 1 level of arousal at recall. To counterbalance for any sequence effects, subjects were randomly assigned to one of the 16 combinations of "order of arousal level at learning", "list order at learning", "list order at recall", and "arousal level at recall" (See Appendix 7 for the actual sequences of the 16 conditions and the main conditions represented by each sequence.

E. Apparatus

A Monark bicycle was used in the exercise condition. The bicycle was set to a tension level of 3 kilopond and connected to a mechanical counter to count the number of revolutions made by the subject within 2.5 minutes on the bicycle.

An optical plethysmograph, monitored via an Aim 65 microcomputer (Rockwell International), was used to record heart rates. Changes in blood volume were counted for 30-s intervals and converted to pulse per minute rates.

A stop watch was used for timing pulse rate and other intervals of time.

III. RESULTS

A. Manipulation Checks on Arousal

To measure physiological arousal, pulse rate was taken. Before and after the 2.5-minute interval of either exercise or relax, the number of pulses during a 2-minute interval was recorded. The dependent measure was the change in pulse rate from pre- to post-task. A 2 x 2 x 2 analysis of variance with repeated measures (ANOVAR) was performed with learning state as a within-subject variable and recall state order as between-subjects variables. A significantly greater increase in pulse rate from pre- to post-task occured during exercise ($\underline{M}$ change $= +35.4$) than during relaxation ($\underline{M}$ change $= +0.81$), $F = 207.4$, $\underline{p} < 0.001$. These results supported the effectiveness of the arousal manipulation.

Mean ratings of the subjective feeling of arousal after exercise and relaxation were 4.46 and 2.29 respectively. An independent t-test indicated a significant arousal effect, $t(46) = 10.47$, $\underline{p} < 0.01$, again demonstrating the effectiveness of the arousal manipulation.

B. Dependent Measures

Our primary concern was whether people remembered better when they learned and recalled in a congruent state than when they learned and recalled in a different state of arousal. In order to examine whether memory was better in a congruent state, the primary dependent measure was the proportion of words recalled on either list in the third phase of the study. A 2 x 2 ANOVAR was performed on the dependent measure with arousal at learning (high or normal) as the within-subject variable and arousal at recall (high or low) as the between-groups variable.

In order to examine whether arousal at recall enhanced recall of emotional material, we compared the average proportion of high emotional words and the average proportion of neutral emotional words recalled between the high arousal and neutral arousal group in the third phase of the study. A 2 x 2 ANOVAR was performed with emotionality of words (high or

neutral) as a within-subject variable and recall state (exercise or relax) as a between-subject variable.

The primary dependent measure was a proportion based on the number of words recalled on a separate list in the third phase relative to the number of words originally learned in the first or the second phase. These proportions did not differ in the four conditions of exercise-exercise, exercise-relax, relax-exercise, and relax-relax. The mean proportions for the four main conditions were 0.52 (s.d.=0.23), 0.59 (s.d.=0.29), 0.54 (s.d.=0.20), and 0.59 (s.d.=0.27) respectively. A 2 x 2 ANOVAR was performed, with arousal at learning (high or normal) as the within-subjects variable and arousal at recall (high or normal) as the between-group variable. There was no significant effect of arousal at learning, $F(1,46)=0.031$, n.s., no effect of arousal at recall, $F(1,46)=1.44$, n.s., and no significant interaction between arousal at learning and arousal at recall, $F(1,46)=0.005$, n.s. The results did not reveal a difference in the proportion recalled as a function of the congruence of learning and recall arousal state.

To examine whether there was any order effect which might obscure the expected difference among the four main conditions, a 2 x 2 x 2 x 2 x 2 ANOVAR was performed, with learning state, learning state order, list order during learning, and list order during recall as within-subjects variables and recall state as a between-subject variable. The only significant effects were an interaction between learning state order and learning state, $F(1,46)=34.34$, $p<0.001$, and an interaction among learning state order, list order during learning, and learning state, $F(1,46)=4.38$, $p<0.04$. On examining these interactions, it was found that the list in the second learning state, i.e. the second list learned, was always better recalled (See Figure 2 & 3). This result, however, should have no effect on the interpretation of the results of the main analysis.

Material with high emotionality was expected to be more accessible in a high arousal recall state. To examine if arousal at recall enhanced recall of emotional material, we calculated the average proportion of high emotional words and the average proportion of neutral emotional words recalled in the high arousal recall state and neutral arousal recall state. The

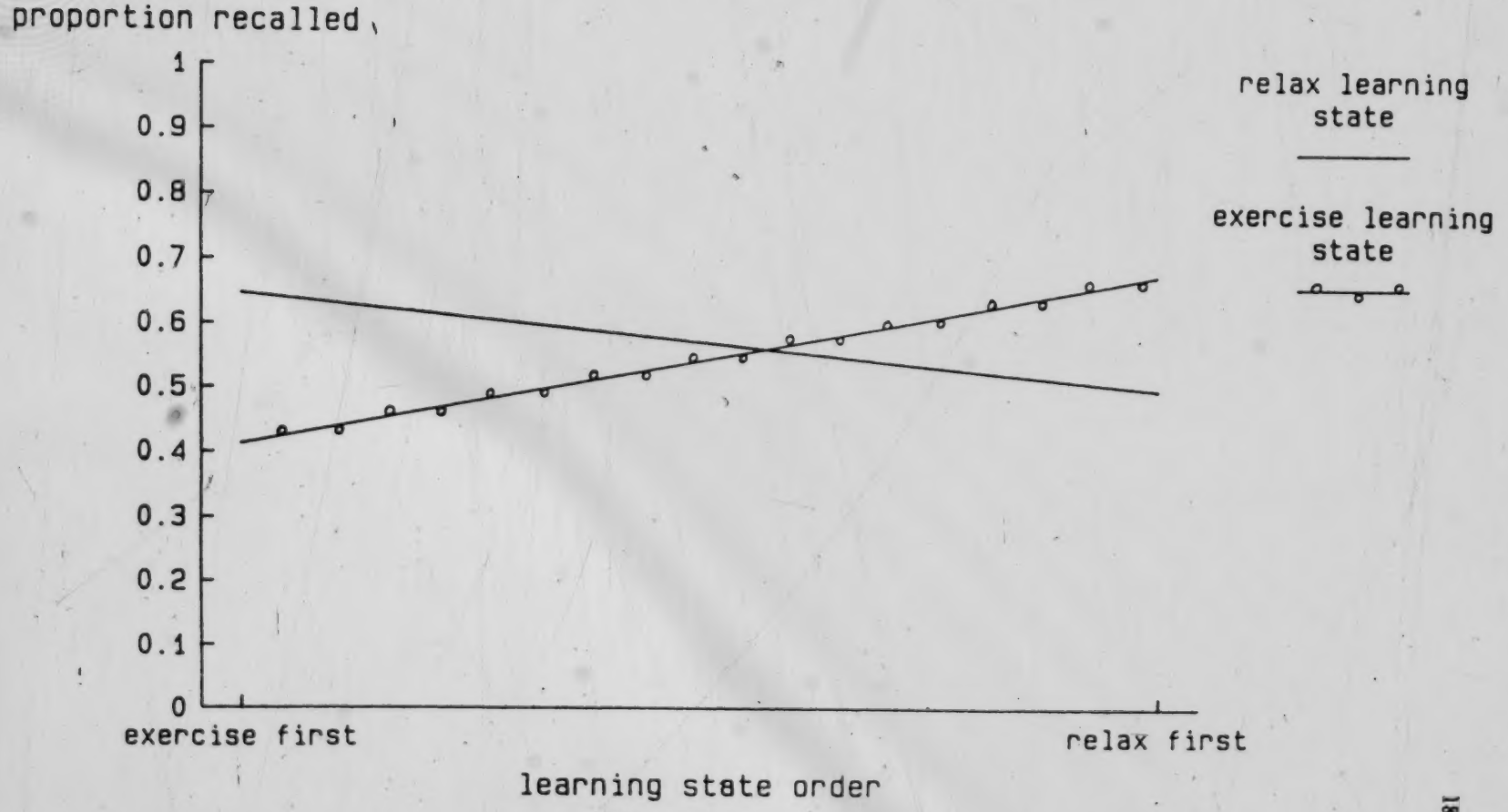


Figure 2. Proportion of Recall in Phase 3 Relative to Recall in Phase 1 or 2 as a Function of Learning State and Learning State Order

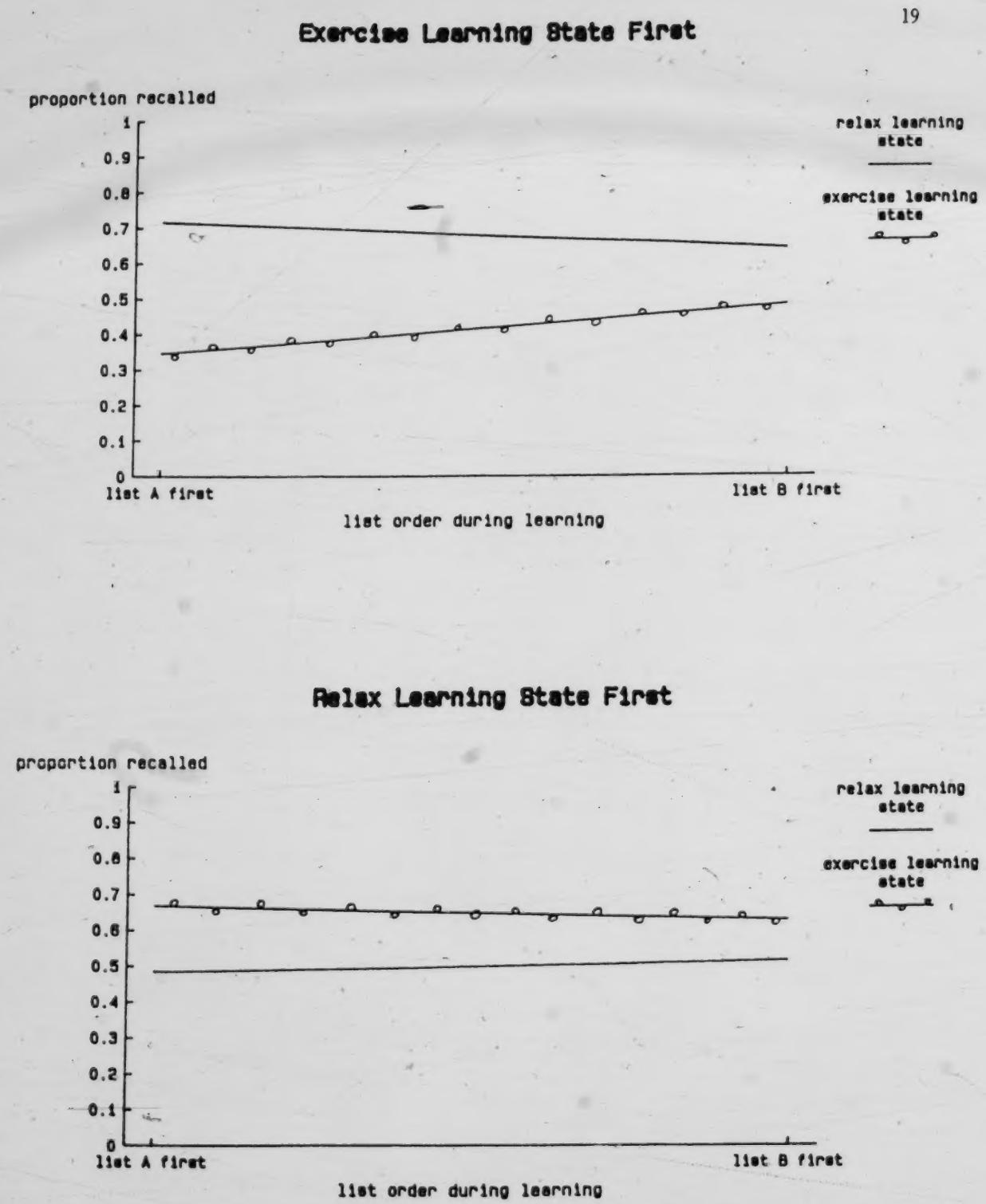


Figure 3 Proportion of Recall as a Function of Learning State, Learning State Order, and List Order During Learning

average proportion of high emotional words was calculated by taking the average of the proportions of high emotional words recalled in list A and list B. The proportion of high emotional words recalled on list A (or list B) was expressed as the number of high emotional words recalled in list A (or list B) in phase 3 relative to the number of high emotional words originally learned in list A (or list B) in either phase 1 or phase 2. The average proportion of neutral emotional words was calculated in the same manner. These proportions are shown in Table 1.

Table 1

Average Proportion of High Emotional Words and Average Proportion of Neutral Emotional Words Recalled for Each Recall State

	Emotionality of Words	
Arousal State at Recall	High Emotional	Neutral Emotional
Exercise	0.656	0.471
Relax	0.677	0.482

A 2 x 2 ANOVAR was performed with emotionality of words (high, neutral) as a within-subject variable and recall state (exercise, relax) as a between-subject variable. High arousal state at recall did not enhance recall of emotional words. Only the emotionality of the words made a difference in memory. A higher proportion of emotional words was recalled regardless of the recall state, $F(1,46)=28.54$, $p<0.001$.

Several post-hoc analyses were significant. The first significant result concerned the pleasantness of the words. The average proportion of pleasant words, the average proportion of unpleasant words, and the average proportion of neutral words recalled during Phase 3 were used as the dependent measure here. The average proportion of pleasant words recalled was calculated by taking the average porportions of pleasant words recalled on list A and list B. The proportion of pleasant words recalled on list A (or list B) was expressed as the number of pleasant words recalled on list A (or list B) in phase 3 relative to the number originally learned in list A (or list B) in Phase 1 or Phase 2. The average proportion of unpleasant words and the average proportion of neutral words recalled were calculated in the same manner. A 2 x 3 ANOVAR was performed with pleasantness of words (pleasant, neutral, and unpleasant) as the within-subjects variable and recall state (exercise or relax) as the between-subject variable. The effect of pleasantness of words were significant, $F(2,92)=10.8$, $p<0.001$. Results of a Newman-Keuls test suggested that high and low pleasant words were better recalled than neutral words (Table 2 presents the average proportion of pleasant, unpleasant, and neutral words recalled).

Table 2

Average Proportion of Pleasant, Average Proportion of Unpleasant, & Average Proportion of Neutral Words Recalled

	Pleasant	Neutral	Unpleasant
Average Proportions	0.615a	0.445b	0.552a

Note : Cells having subscripts in common do not significantly differ. Cells having different subscripts differ significantly at the 0.05 level.

Another analysis used the average proportion of high emotional pleasant words and the average proportion of high emotional unpleasant words as dependent measures. The average proportion of high emotional pleasant words recalled was calculated by taking the average of the proportions of high emotional pleasant words recalled in list A and list B. The proportion of high emotional pleasant words recalled in list A (or list B) was expressed as the number of high emotional pleasant words recalled in list A (or list B) relative to the number of high emotional pleasant words originally recalled in list A (or list B) in Phase 1 or Phase 2. The average proportion of high emotional unpleasant words was calculated in the same manner. A 2 x 2 ANOVAR was performed on this dependent measure with pleasantness of words as a within-subject variable and recall state as a between-subjects variable. Analysis showed that a higher proportion of high emotional pleasant words were recalled than high emotional unpleasant words, $F(1,46)=5.606$, $p<0.02$ (See Table 3 for the average proportions of high emotional pleasant words and the average proportion of high emotional unpleasant words recalled).

Table 3

Average Proportions of High Emotional Pleasant and Average Proportions of High Emotional Unpleasant Words Recalled

	High Emotional Pleasant Words	High Emotional Unpleasnt Words
Average Proportion Recalled	0.662	0.554

Because the above dependent measures and analyses used did not explicitly show how different

type of words were learned in the first place and did not allow for comparisons of different type of words recalled, a different independent measure was used. To see how different types of words were initially learned and how well they were learned and recalled compared with other types of words, the mean proportion of each type of words (the number of words recalled relative to the total possible number of words for each type of word) was calculated and is plotted in Figure 4.

It can be seen from the graph that high emotional pleasant words were best recalled, followed by high emotional words and high pleasant words. The other categories of words -- high emotional unpleasant, neutral emotional, unpleasant and neutral -- were least well learned and recalled. Moreover, the proportion of words learned and recalled did not differ much among these types of words. There was, however, a larger difference in the proportion recalled in the second list recalled (T4) which may be due to interference from the first list recalled (T3).

Further analysis of the proportions recalled of different types of words learned according to arousal at learning state did not show a difference in learning different types of words under different learning state (See Table 4). Learning state arousal had no effect on the type of words learned.

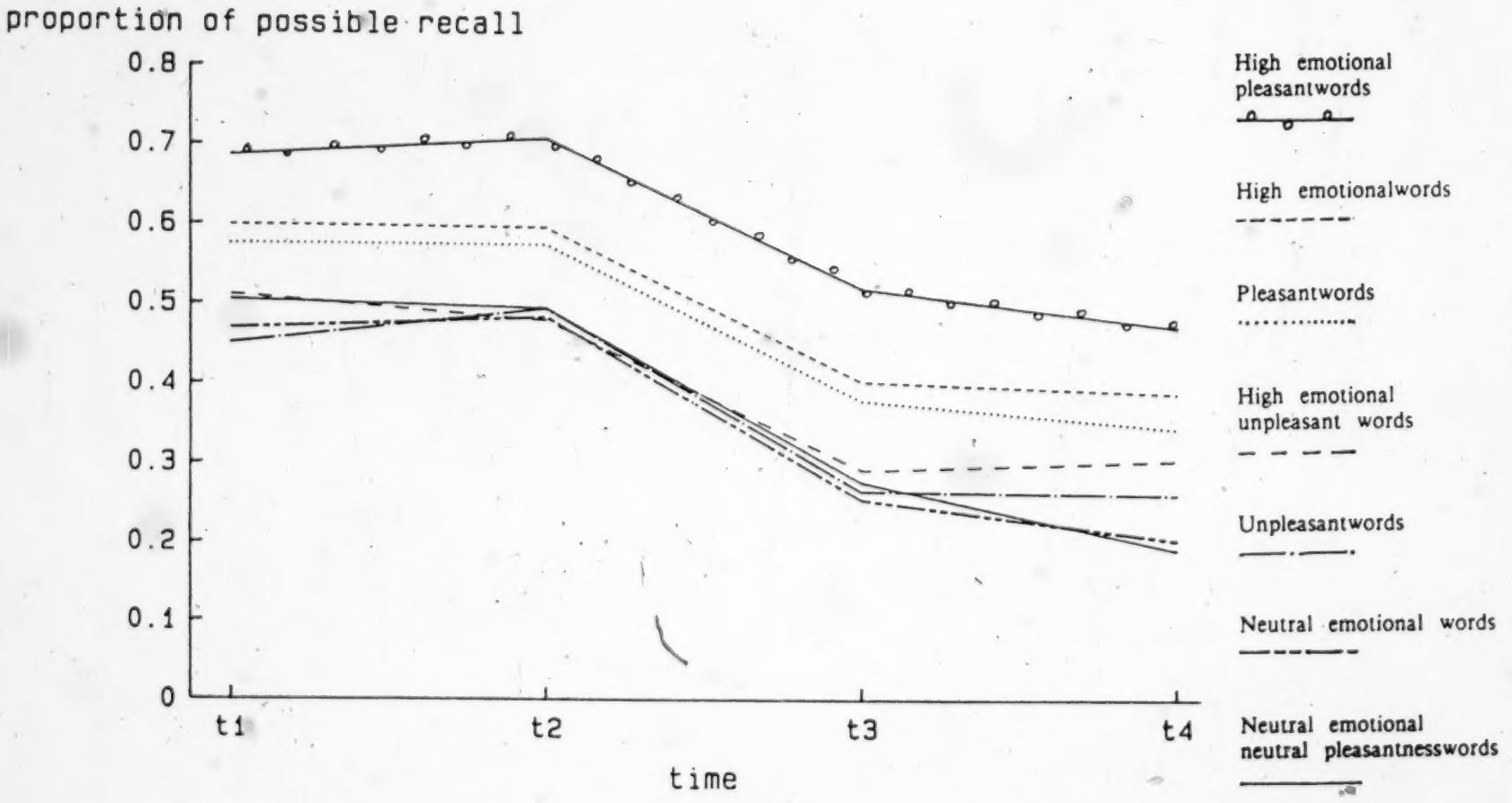


Figure 4 Mean Proportion of Words Recalled Relative to the Total Number of Possible Recall for Each Type of Word

Table 4

Average Proportion of Each Type of Words Recalled at Different States of Arousal During Learning

	Learning State Arousal	
Proportion Recalled	Exercise	Relax
Proportion of high emotional pleasant words	0.697	0.697
Proportion of high emotional words	0.594	0.602
Proportion of pleasant words	0.575	0.576
Proportion of neutral words	0.489	0.511
Proportion of high emotional unpleasant words	0.484	0.505
Proportion of neutral emotional words	0.476	0.477
Proportion of unpleasant words	0.463	0.481

The results of the second part of the study were variable. People did not seem to bias their judgment in a more aroused state for all types of emotions. For the "sad", "annoy" and "glad" ratings, there was no main effect of arousal state at recall, $F(1,44)=2.087$, n.s., $F(1,44)=0.129$, n.s., and $F(1,44)=0.243$, n.s. respectively. There was however a significant effect of arousal state on "apprehensive" ratings, $F(1,46)=4.072$, $p<0.05$. This result was opposite to that predicted, where subjects in the relax recall state actually judged phrases as uttered by more fearful people. A main order effect of learning states occurred in "glad" ratings, $F(1,46)=4.93$, $p<0.032$, where subjects judged individuals as more ecstatic when they received exercise first in their learning state. There was also a significant interaction between recall state and previous order of learning states on "annoy" ratings, $F(1,46)=4.234$, $p<0.05$,

suggesting that immediate exercise before relax recall state increased ratings of annoyance but exercise occurring immediately before exercise recall state lowered ratings. The same trend was observed in the "apprehensive" ratings, although the interaction was not significant at the 0.05 level (See Table 5 for mean ratings).

Table 5

Sum of Mean Ratings for Different Types of Emotional Phrases in Each Type of Recall State

	Type of Emotional Phrases			
Recall State	Sad	Annoy	Apprehensive	Glad
Exercise	17.458	16.000	14.542	20.875
Relax	18.792	15.542	16.792	21.375

IV. DISCUSSION

Our attempt to demonstrate that mood influences memory due to change in arousal level was not successful. Mood state retention was not demonstrated when high arousal, induced by strenuous exercise, was used to manipulate the state. Moreover, high emotional words were not better recalled in the high arousal recall state. Hence, high arousal did not seem to serve as a retrieval cue to increase accessibility of similarly toned material via information about change in arousal.

We also attempted to show that arousal biased judgment of others' emotion. Contrary to our expectations, arousal did not bias judgment of others' emotion in the predicted direction. Again, arousal did not serve as a cue to make high arousal materials more accessible and then affect judgment.

Our failure to demonstrate mood-state dependent retention was not unique. Recently Bower and Mayer (1985) also failed to replicate their early findings on mood-dependant retreival (Bower et al,1978; Bower et al,1981). There are theoretical as well as methodological explanations as to why we did not get what we expected. First, we question the assumption that it is information of arousal change that is stored in memory and later retrieved that produced the SDR effect in Clark et al (1983)'s study. It is possible that the SDR effect obtained might be due to the positive mood that was induced by mild exercise in their first study and by watching a sexually explicit film in their second study. Moreover, the lack of an SDR effect might be explained by the relative generality of the arousal cue. Information about change in arousal level may be too general a cue to discriminate between arousal related and arousal unrelated material. To have a mood SDR effect, it seems important that arousal is accompanied by other aspects of mood (e.g. distinct facial expressions, physical postures, evaluation of how fortunate one is) that are linked to affectively toned material (Clark et al, 1983).

On the other hand, information about change in arousal level might serve as a retrieval cue within certain limits of arousal levels. Outside these limits, change in arousal level may produce other effects that interfere with the normal cueing effect of arousal. The high level of

arousal attained in the exercise condition, or the amount of change in arousal in the subjects of the present study may produce distraction and fatigue which compete with the priming effect of arousal. Indeed, lower proportions of words were recalled in this study than in Clark et al's (1983) study. However, there is no way of teasing out the effects due to distraction and/or fatigue from those due to cueing in the present design. Moreover, it must be pointed out that the poor proportions of words recalled in the present study may not be due to distraction and/or fatigue. The fact that there were fewer learning trials in the present study as compared to Clark et al's study undoubtedly lowered the total proportion of words recalled in the present study. In Clark et al's study, the subjects listened to the list of 20 phrases twice, recalled the list aloud, listened to the list for a third time, and recalled the phrases aloud for a second time. The number of words recalled at the second time was recorded and referred to as their original learning. In our case, subjects listened to a list of 20 words twice and then recalled the list on a piece of paper. Other studies that used a methodology similar to ours (e.g. Bower et al, 1978) have reported similar percentage of words recalled when averaging recalls over groups in the congruent, control, and incongruent state. Thus, we are quite confident that the absence of SDR is not due to distraction and/or fatigue. Nor it is the number of learning trials that is important in inducing mood state dependant learning through changes in arousal level.

Another methodological issue may be more important in influencing the effect of arousal as a cue on processing. This is the categorization of words in the list. Categorization may serve as a stronger cue to override the cueing effect of arousal. In commenting on the article by Hasher, Rose, Zacks, Sanft, & Doren (1985), Mayer & Bower (1985) suggested that one of the reasons why they did not get mood-congruent effects was due to multiple coherence relations connecting the text statement used for recall. Mayer & Bower (1985) concluded that "items should be relatively independent of one another, almost like items on unrelated word list or unrelated incidents from one's personal past" to produce mood congruent learning. Selective recall will be reduced to the extent that items are strongly interassociated in natural coherent units so that they will trigger recall of one another (Mayer & Bower, 1985). In an attempt to

account for the failure to find the mood retrieval effect originally reported by Bower et al (1981), Ellis (1985) addressed the importance of task variables. Using the Velten mood-induction procedure, Ellis (1985) were able to demonstrate that a depressed-mood induction impaired retrieval from episodic memory when the task consisted of target words imbedded in a set of unrelated sentences. Thus, they concluded that the more demanding the task, the greater will be the chance of mood retrieval effect. An incoherent story, for example, demands more encoding than an organized story and consequently facilitates mood retrieval effect. Ellis (1985) suggested that task difficulty can be defined in terms of list length, cognitive effort demands, and opportunities for category organization in experiments that use list learning. In the present study, subjects might have categorized the words on the lists to help themselves in memorizing the list. Possible categories might be pleasant, neutral, or unpleasant words and positive affective words versus negative affective words.

In subsequent research, it is advisable to minimize the potential possibility of category organization in the lists. Such a list may be difficult to construct if different types of words need to be examined for their effect on mood memory. It may be much easier to use a prose passage that is poorly organized as recall material. If there is still no SDR and priming effects of arousal, it is likely that the problem of the present study is not methodological but theoretical.

Besides the theoretical explanation of the absence of cueing effect in change of arousal, the fact that high emotional words, both positive and negative, were not better recalled in the high arousal recall state can be explained by saying that the items are invalid. One can argue that the emotional words used in the present study were not originally encoded in a high arousal state and therefore not associated to an information node that registers change of autonomic arousal. Activation of the information node of arousal therefore did not activate these items to give mood retrieval effects. Teasdale and Russell (1983) also stressed the importance of the nature of the material used. They suggested that it was necessary for the material used to have been differentially associated with that particular mood state in the subjects' life experience

before mood retrieval effects can be observed. In the same way, it seems that the emotional items in our lists should have been associated with arousal state in the subjects' life experience in order to have retrieval effects in the present study. Were the words on our lists such as love, anger, hatred, kiss, etc. associated with arousal state in the subjects' life experience? Our guess is that they were, making the above argument that our emotional words were not valid items quite implausible.

Although high emotional words were not better recalled in the high arousal recall state, they were generally better recalled than the neutral emotional words and the neutral words. This finding coincides with the prediction from Walker's theory (as discussed in Eysenck, 1977) on memory and arousal. In his theory, high arousal items are expected to be better recalled in memory over long intervals because it is assumed that high arousal items have the effect of producing a longer lasting active trace than low arousal items. But because of a larger, initial inhibition of retrieval in high-arousal items, it is expected that low-arousal items should be better recalled than high-arousal items at short retention intervals. Analysis of the proportions of high emotional and low emotional words recalled at different retention intervals confirmed the first part of the theory but not the second part. High emotional words were better recalled even immediately after the learning session.

Similarly, pleasant and unpleasant words were better recalled than neutral words regardless of recall state and recall interval. Similar results were reported by Hasher et al (1985a). Happy and sad items from prose were found to be better remembered, but no explanation was provided for the unexpected results. The greater number of pleasant words recalled can be explained by the greater number of associates for pleasant words. As early as the 1930s, White (1936) reported the greater recall of pleasant words and explained this finding in terms of larger number of associates for pleasant words. Isen (1985) also suggested that positive materials have broader networks and therefore are more readily cued. The reason for the better recall of unpleasant words, however, is not known.

We can conclude from the results obtained in the first part of the study that memory is affected only by the nature of the words. High emotional, high pleasantness, and high unpleasantness words were all better recalled than neutral words. High arousal level did not produce SDR or mood retrieval effects.

In the second part of the study, the participants' arousal did not bias their judgment of others' emotions as being more aroused. Again, arousal did not serve as a cue to make high arousal materials more accessible and then affect judgment in the more aroused direction. Alternatively, one can argue that arousal may have increased accessibility, but because of the contrast effect, subjects in high aroused state judged others' emotions as less aroused when compared with their own state of arousal. There was some evidence favouring this alternative. Subjects actually judged people to be less apprehensive when they were in the aroused state as compared to those in the relaxed state. Although this argument may be plausible, we have little confidence that this is the case. Several significant interactions of learning state order with recall state suggested that it is not advisible to have memory studies before judgment studies.

In conclusion, we question the finding by Clark et al (1983) that showed that change in arousal could be stored in memory and could serve as a retrieval cue. Using higher level of arousal, we did not find that arousal served as a retrieval cue. It is thus fair to say that mood may not be represented in memory in the form of an information node about arousal change. The theory proposed by Clark et al (1983) may not be fruitful in understanding mood effects on memory and judgment. Even if arousal can serve as a cue, it is a cue so weak that in the presence of other stronger cues, such as category organization in materials used, its effect is overridden. Moreover, arousal alone cannot produce SDR or increase accessibility of high emotional items. There is something in mood (perhaps the pleasantness/unpleasantness dimension) that is essential in producing mood effects. Thus arousal itself is not sufficient to produce mood effects. On the other hand, moods produce effects that are not typical of arousal. In some studies, happiness facilitated creative and unusual responding that are not typical responses of "aroused" persons (Isen, Johnson, Mertz, & Robinson, 1985; Isen &

Daubman, 1984; Isen et al, 1982).

As suggested by Mandler (1984, p.277; as cited in Isen et al, 1985), arousal may not be a central component in mood states. Moreover, the "spreading activation" theory proposed by Bower (1981) to explain mood effects also need close scrutiny. Hypotheses derived from the theory were not supported in the studies of Clark, Teasdale, Broadbent, & Martin (1983) and Gerrig and Bower (1982). The theory would propose a lowering of perceptual thresholds for mood-congruent words and an elevation of thresholds for mood-incongruent words. The results of Gerrig and Bower (1982), however, failed to support this notion. Mood-congruent words were not correctly selected more often than neutral or incongruent targets. Mood-congruent words did not have lower recognition thresholds than neutral and incongruent words. The fact that mood had no effect on lexical decision time (Clark et al, 1983) of mood-congruent words further questions the validity of using the "spreading activation" theory to explain mood congruent effects. In the future, it may be more fruitful to investigate how emotional words are organized in memory to have a better understanding of how moods operate.

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VI. Appendix 1

List A

	Pleasantness (P)	Emotionality (E)	Concreteness (C)	Familiarity (F)
Joy	6.74	6.45	3.54	6.27
Caress	6.38	6.48	4.31	-
Marry	5.97	6.21	4.46	6.31
Dear	5.82	6.00	2.75	6.10
	(6.23)•	(6.29)	(3.77)	(6.23)
Temper	2.57	6.45	3.23	-
Quarrel	2.06	6.03	3.92	5.37
Hatred	1.40	6.39	3.49	-
Anxiety	1.97	6.13	2.69	-
	(2.00)	(6.25)	(3.23)	(5.37)
Eating	6.00	3.68	4.61	6.71
Good	6.17	3.94	2.87	6.66
Healthy	6.46	3.55	3.87	-
New	5.80	3.30	3.08	-
	(6.11)	3.62	3.61	(6.69)
Vanity	2.31	4.73	2.46	-
Slow	2.82	2.90	3.17	6.71
Excuse	2.94	3.47	4.38	5.76
Dirty	1.86	2.91	3.95	-
	(2.48)	(3.50)	(3.49)	(6.24)
Ask	3.94	3.68	3.86	-
Conduct	4.00	3.58	3.67	-
Option	4.03	2.91	2.92	-
Priority	4.29	3.81	3.06	-
	(4.07)	(3.50)	(3.38)	-
	P=4.17	E=4.17	C=3.49	F=6.13

• Figures in parethesis are means of the four figures directly above.

Appendix 1b

List B

	Pleasantness (P)	Emotionality (E)	Concreteness (C)	Familiarity (F)
Kiss	6.76	6.87	5.19	6.63
Happy	6.60	6.18	3.56	6.84
Love	6.60	6.79	3.44	-
Beauty	6.49	5.91	2.51	6.52
	(6.61)	(6.44)	(3.68)	(6.66)
Afraid	2.49	5.85	3.05	6.24
Anger	1.91	6.67	3.67	6.19
Sad	2.53	5.91	2.74	6.44
Die	1.83	5.85	3.87	6.43
	(2.19)	(6.07)	(3.30)	(6.33)
Clean	6.21	3.77	4.00	6.48
Leisure	5.97	2.94	3.05	-
Sleeping	6.18	4.29	3.61	-
Success	6.40	4.82	3.56	-
	(6.19)	3.96	3.55	(6.48)
Stupid	2.03	3.70	3.15	6.24
Stolen	1.56	4.06	3.67	-
Penalty	2.34	3.52	3.87	-
False	1.71	3.91	2.97	-
	(1.91)	(3.80)	(3.42)	(6.24)
Choice	4.46	3.06	3.72	-
Custom	4.20	3.27	3.42	6.05
Deep	4.11	3.94	3.05	6.27
Little	4.31	2.97	3.56	6.46
	(4.27)	(3.31)	(3.44)	(6.26)
	P=4.24	E=4.72	C=3.48	F=6.39

VII. Appendix 2

List C (sad vs. distress)
1. 'I feel down-hearted'
2. 'Every thing is not working'
3. 'I feel like crying'
4. 'I do not feel like talking to people'
5. 'Life is not enjoyable'

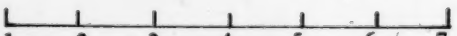
List D (annoyed vs. rage)
1. 'Get out of my way'
2. 'I'm ticked'
3. 'What a dumb thing to do!'
4. 'That's irritating'
5. 'What on earth are you doing?'

List E (apprehensive vs. terrified)
1. 'Will there be any danger?'
2. 'I think it's better for us to leave this place'
3. 'What can I do now?'
4. 'I'm not sure what had happened'
5. 'Will he get hurt?'

List F (glad vs. ecstatic)
1. 'What a good idea'
2. 'Things are getting on very well'
3. 'I feel I am on the top of the world'
4. 'What a wonderful time'
5. 'Life is full of excitment'

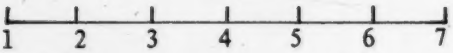
VIII. Appendix 3

Please judge the emotion of the person who said the following phrases according to the scale given. Put the rating in the blank at the beginning of each phrase.

A. Sad  Distress

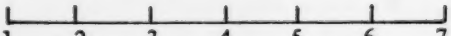
1 2 3 4 5 6 7

---- 'I feel down-hearted'
---- 'Every thing is not working'
---- 'I feel like crying'
---- 'I do not feel like talking to people'
---- 'Life is not enjoyable'

B. Annoyed  Rage

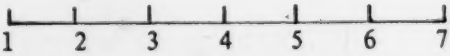
1 2 3 4 5 6 7

---- 'Get out of my way'
---- 'I'm ticked'
---- 'What a dumb thing to do!'
---- 'That's irritating'
---- 'What on earth are you doing?'

C. Apprehensive  Terrified

1 2 3 4 5 6 7

---- 'Will there be any danger?'
---- 'I think it's better for us to leave this place'
---- 'What can I do now?'
---- 'I'm not sure what had happened'
---- 'Will he get hurt?'

D. Glad  Ecstatic

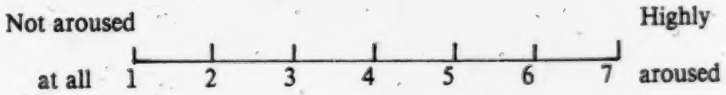
1 2 3 4 5 6 7

---- 'What a good idea'
---- 'Things are getting on very well'
---- 'I feel I am on the top of the world'
---- 'What a wonderful time'
---- 'Life is full of excitment'

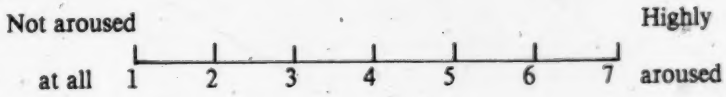
IX. Appendix 4

Please rate your subjective state of physiological arousal

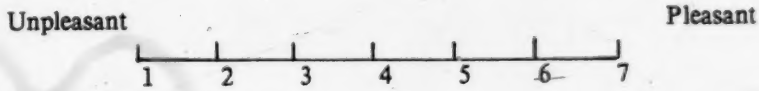
(i). under exercise condition (after pedalling on an exercise bike) :

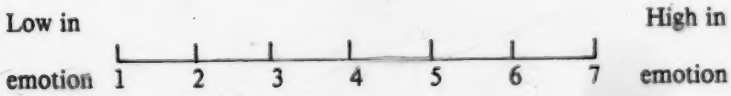


(ii). under relaxation condition (after sitting in a quite room) :



Please rate your degree of pleasantness and emotionality immediately after exercise :





X. Appendix 5

Screening Procedure for Subjects
Participating in a Strenuous Exercise Task
[Maximum exertion: 1500 kilopond m per min for two min]

	Yes	No
Are you older than 25 years of age?	-----	-----
Did you ever have any kind of heart disease?	-----	-----
Do you have any kind of heart disease now?	-----	-----
Did you ever, especially after physical exercise, experience that the rhythm of your heartbeat is disrupted and become irregular?	-----	-----
Do you get chest pains after physical exercise?	-----	-----
Does physical exercise make you nauseous or dizzy?	-----	-----
Do you suffer from shortness of breath after minor exertion?	-----	-----
Do you have daily coughing attacks that produce something you have to spit out?	-----	-----
Do you suffer from acute muscle pain at present?	-----	-----
Do you suffer from acute muscle pain after physical exercise?	-----	-----

[Any yes in response to these questions* will result in the dismissal of the subject.]

* This questionnaire is adapted from one suggested in Morse, R. L. (Ed.), Exercise and the heart: Guidelines for exercise programs. Springfield, Ill. : Thomas, 1972.

XI. Appendix 6

Debriefing

We are interested in your judgment, memory for and evaluations of stimuli especially after you are in a state of physical arousal. It has been suggested that when people learn material under such conditions they remember it better only under similar conditions. This is called mood-state dependent learning. A review of the relevant literature suggested that level of arousal underlying mood states may important in inducing mood-state dependent retention. Thus, arousal state is manipulated using exercise. On the other hand, type of to-be-recalled material was manipulated since there was some evidence that suggests positive material is better recalled in positive mood and negative material better recalled in negative mood. In the experiment, appropriate levels of arousal was manipulated using exercise or relaxation. You learned and recalled a list of words in an exercise condition and then learned and recalled another list of words in a relaxation condition. Then you were asked to recall both lists of words under either condition. The dependent measure was the proportion of words remembered relative to the number originally learned. These proportions will then be compared to see if the list learned and recalled in a similar condition will be better recalled. Also, we expect high emotional words, both positive and negative, to be better recalled in the arousal condition.

XII. Appendix 7

Main Conditions*	First Learning State	Second Learning State	Recall State
I,II	exercise(list A)	relax(list B)	exercise(list A first, list B second)
I,II	exercise(list A)	relax(list B)	exercise(list B first, list A second)
I,II	exercise(list B)	relax(list A)	exercise(list A first, list B second)
I,II	exercise(list B)	relax(list A)	exercise(list B first, list A second)
III,IV	exercise(list A)	relax(list B)	relax(list A first, list B second)
III,IV	exercise(list A)	relax(list B)	relax(list B first, list A second)
III,IV	exercise(list B)	relax(list A)	relax(list A first, list B second)
III,IV	exercise(list B)	relax(list A)	relax(list B first, list A second)
II,I	relax(list A)	relax(list B)	exercise(list A first, list B second)
II,I	relax(list A)	relax(list B)	exercise(list B first, list A second)
II,I	relax(list B)	relax(list A)	exercise(list A first, list B second)
II,I	relax(list B)	relax(list A)	exercise(list B frst, list A second)
IV,III	relax(list A)	relax(list B)	relax(list A first, list B second)
IV,III	relax(list A)	relax(list B)	relax(list B first, list A second)
IV,III	relax(list B)	relax(list A)	relax(list A first, list B second)
IV,III	relax(list B)	relax(list A)	relax(list B first, list A second)

*Main Condition I : exercise - exercise
Main Condition II : relax - exercise
Main Condition III : exercise - relax
Main Condition IV : relax - exercise